5. Theatre of Operations: An entertaining problem

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Abstract

System requirements and constraints specify how a system must look, feel and function; but it is the needs of the users and stakeholders that give the system its raison d'etre. If a valid solution system is to be delivered, the end-users' needs must be correctly identified, within the stakeholders' constraints. While this process forms an essential part of the concept phase of the engineering lifecycle, it is often left under-done, with needs attributed to the general, non-specific "user". Since needs vary per user, it is of critical importance to identify who the end-users are, what their role in the operational behaviour of the system entails, and from where they came. Similarly, when considering stakeholder constraints it is necessary to identify who the stakeholders are, what their influence on the system entails, and from where they view the system.

One of the more significant changes to the US Department of Defense Architecture Framework (DoDAF) from version 1.5 to 2.0 is the manner in which operational entities are considered. In version 2.0, 'Performers' were added to the DoDAF meta-model to capture those entities responsible for performing the representative activities which make up the operational scenarios. These Performers replaced the often over-used and poorly-understood 'Operational Nodes'.

Additionally, capability stakeholders offer requirements, in the form of constraints, which bound the problem space. These constraints, in combination with the user needs, allow the systems engineer to understand the operational concept of the capability. User needs and other stakeholder requirements are identified and described from the perspective of a particular class of stakeholder. To address these perspectives, each stakeholder-class and their environment is modelled with emphasis on identifying what they need the system of interest to be or not to be - i.e. what they need to achieve (goals and objectives), and to what they need to conform (limitations and constraints). The aggregate model of all stakeholders is thus an integrated architecture description of the problem space (ISO42010 2008).

Effective needs analysis requires complete understanding of the users and how they act as operational performers, their roles, and the organisations to which they belong. This presentation provides an entertaining yet rigorous example and uses colloquial language to describe in readily understood terms a robust needs analysis methodology that is effective, efficient and also compliant with the Defence Architecture Framework (DAF). The example demonstrates the application of a model-based approach to concept engineering and, in particular, how a better understanding the 'performers' leads to a solid basis on which to design a solution.

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14. ABSTRACT
System requirements and constraints specify how a system must look, feel and function; but it is the needs of the users and stakeholders that give the system its raison dâetre. If a valid solution system is to be delivered, the end-usersâ needs must be correctly identified, within the stakeholdersâ constraints. While this process forms an essential part of the concept phase of the engineering lifecycle, it is often left under-done, with needs attributed to the general, non-specific âuserâ. Since needs vary per user, it is of critical importance to identify who the end-users are, what their role in the operational behaviour of the system entails, and from where they came. Similarly, when considering stakeholder constraints it is necessary to identify who the stakeholders are, what their influence on the system entails, and from where they view the system.

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Presenter Biographies

Tommie Liddy is a mechatronic engineer completing his Ph.D. in Robotics at the University of Adelaide while working as part of the Model-Based Systems Engineering (MBSE) team at Aerospace Concepts. His academic study has focused on navigation control for Ackermann vehicles and uses vector fields as control schemes. Development of this work was achieved through simulation of vital concepts then a physical implementation of the final system. As part of the MBSE team at Aerospace Concepts Tommie is developing MBSE tools for operational analysis and capability definition.

Michael Waite has been working as a professional engineer for over ten years since completing his Bachelor of Engineering (Mechatronics) degree in 2001. His career has seen him working for several multi-national automotive companies in Australia, Asia and Europe, including Mitsubishi Motors, Ford and Caterpillar. He currently works for Aerospace Concepts, a systems engineering consulting company, specialising in the development of complex-system capabilities.

Paul Logan, following a twenty-three career in the Australian Army, has acquired twenty years of experience with model-based systems engineering methods, techniques and tools. He introduced MBSE into the Jindalee Operational Radar Network project in 1991 and has since applied model-based analysis and design in commercial and military projects. From 2002 Paul has been involved in Capability Definition Document (CDD) development for the Defence Department. Paul is a certified instructor of Vitech Corporation's introductory and advanced courses on Model Based Systems Engineering using CORE®. Paul holds Bachelor of Engineering (Communications) and Master of Information Science degrees. He is a member of INCOSE, IEEE and SESA, of which he is a former President.

Dr David Harvey is a systems engineer with a particular interest in Model-Based Systems Engineering. He holds a bachelor degree and a doctorate, both in the field of mechatronics. He currently leads the Model-Based Systems Engineering (MBSE) program at Aerospace Concepts Pty Ltd. This team is developing an MBSE approach and tailored tool to assist in complex system definition in conjunction with Australian Defence partners. As well as this development, he is also involved in applying the tool and approach to capability definition in major Australian Defence projects.

Presentation

AEROSPACE CONCEPTS

Theatre of Operations

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Presentation Scope

- The "context"
  - Model-Based Systems Engineering (MBSE)
  - User Needs
    - Operational analysis
    - The performer
- The "solution"
  - The methodology we use to keep focus on the users
  - Intent and focus on user needs
- An "entertaining" example
  - Theatre company - The Scottish Play
  - Abstraction to general model

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What is MBSE

- What is Systems Engineering?
  - Systems engineering involves taking a **structured approach** to definition, design and implementation of systems that address defined **user** problems
- What pushes us towards Model-Based?
  - Outsourcing (Sparrow & Wegner 2011)
    - Recording systems knowledge, while retaining the understanding of how to find it
  - Increasing complexity of projects vs understanding capacity (Metcalfe's Law vs Miller's 'Magical Number')
  - Teams of Systems Engineers

Where do we use MBSE

MBSE can aid in defining needs and functionality **early in the development cycle** and then proceeding with design synthesis and system validation while considering the **entire systems lifecycle**

Benefits of MBSE

- Focus on the information of and about the system leads to a number of benefits
  - Traceability
    - Links established and maintained as part of the approach
  - Consistency
    - 'Single source of truth'
  - Adaptability
    - Any number of views or documents can be produced as snapshots of slices of the model
  - Robustness & information sharing
    - System information made explicitly clear
    - Domain specialist views are possible – without neglecting the interconnected nature of domains

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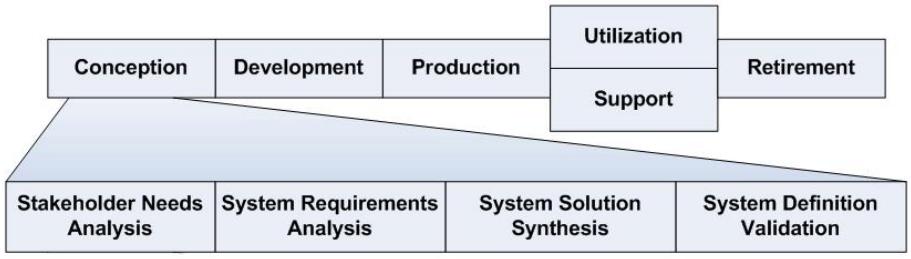
MBSE in the Conception Phase

- Conception phase
  - Needs analysis
  - Requirements analysis



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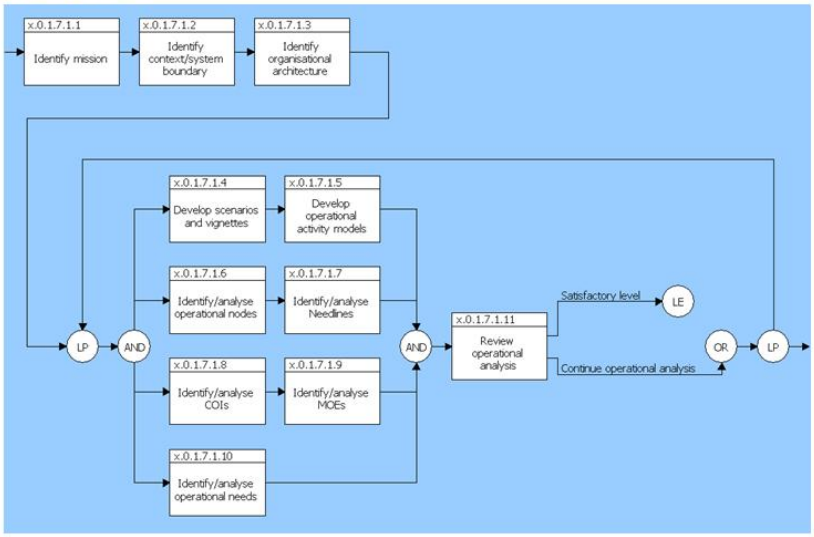
MBSE in the Conception Phase

- A detailed look at the conceptual phase, this is how we gather the User's needs

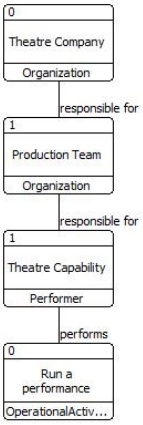


User Needs

When **MBSE** is applied to capability definition we are able to help people **Ask** for what they **Need**, not just what they **Want**, ensuring the **User** is **King**

An Entertaining Example

- The CONOPS: A travelling theatre company, putting on "The Scottish play" in a new town.
  - There is a Theatre Company (the Organisation)
  - Who, when mobilised to put on a performance, are given roles to play
  - It has Actors, Crew and Management (the "Performers")
  - And activities to perform (Scenarios and Vignettes)



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The Scottish Play

Theatre Company Organisation	Roles in The Scottish Play	The Performers
Cast	Principal Actor	Macbeth Lady Macbeth
	Support Actor	Macduff Duncan Banquo Banquo's ghost Angus Ross Witches three Others...
Crew	Back Stage Crew	Stage Hand Lighting guy Sound guy Wardrobe Stage manager
Production	Management	Producer Director Marketing Playwright

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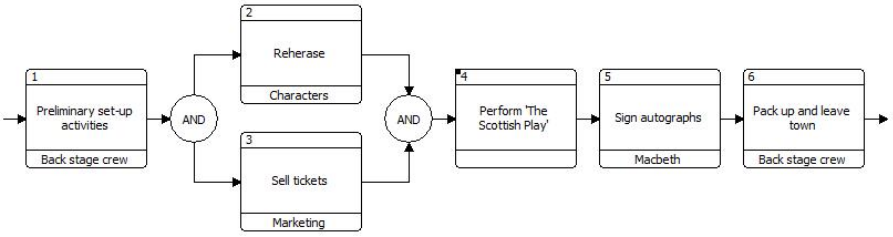
The Scottish Play

- Our "Campaign" involves the theatre company putting on a performance
  - Note: that this is a simplified model for use in this example, and is therefore not intended to be complete
- Each activity is decomposed down until the activity is performed by a single Performer (i.e. a user class)



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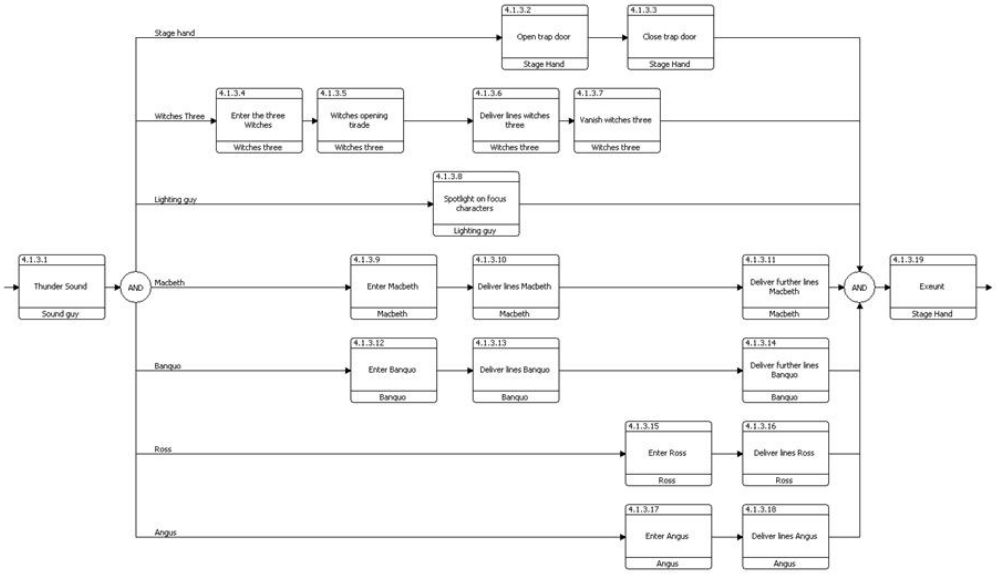
Thunder. Enter the Three Witches

- An example Vignette in our Campaign…Act I Scene III



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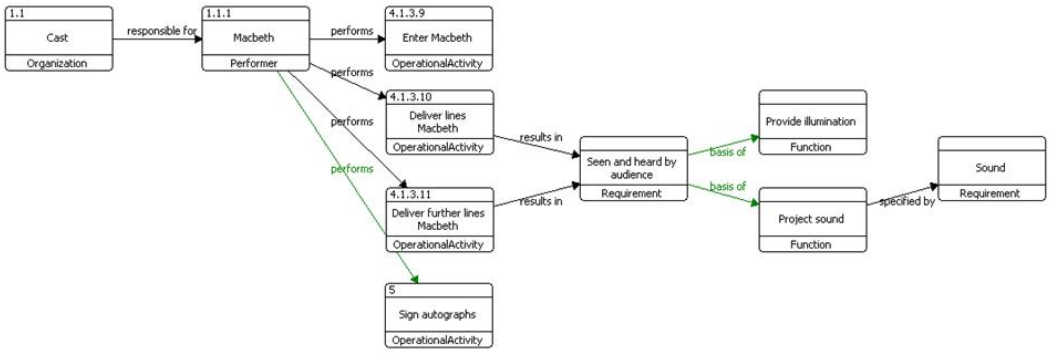
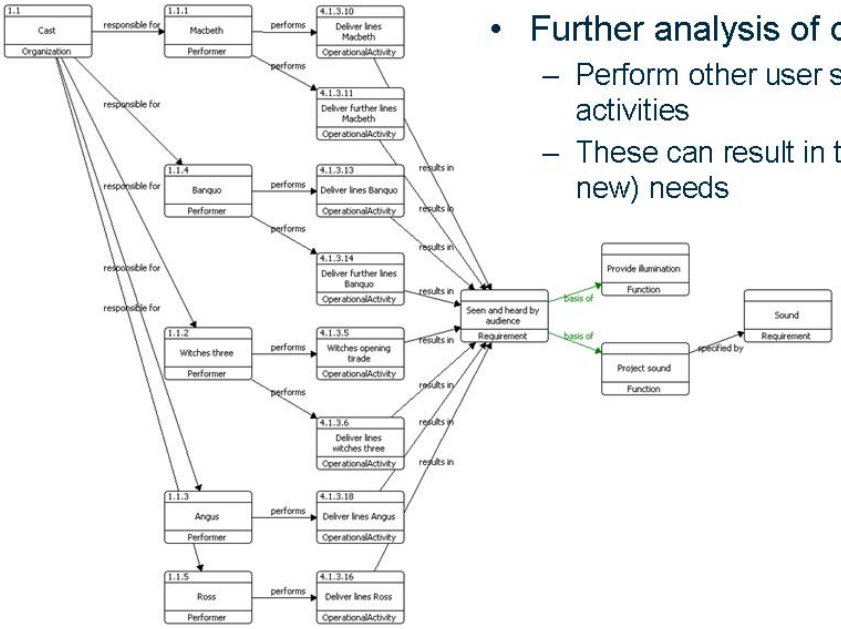
Following a Thread

- The user **Macbeth**
  - A member of the **Cast**, in the principal actor role, becomes the performer **Macbeth**
  - **Macbeth** performs activities in Act I Scene III, such as **Delivering Lines**, and these result in **User Needs**



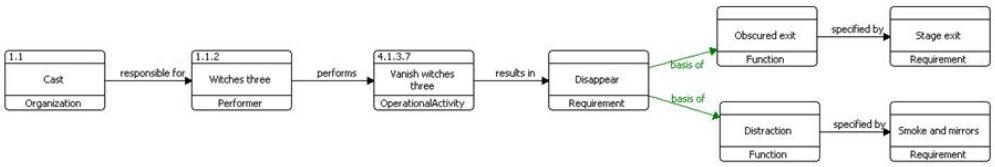
Following Many Threads

- Further analysis of other users
  - Perform other user specific activities
  - These can result in the same (or new) needs

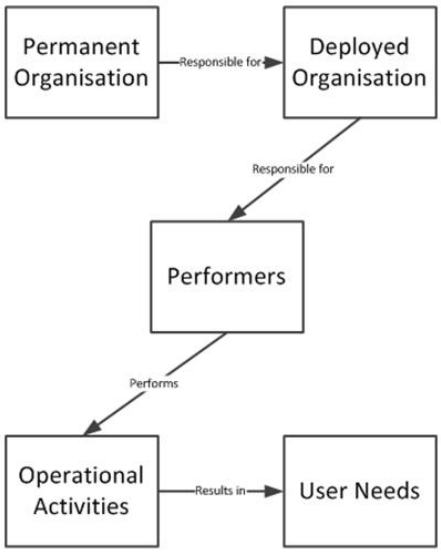


Grouping Users

- The Witches Three
  - The three witches are aggregated up to be a single Performer
  - This decision is based on the level of detail in the Activity Model and the commonality of the Performers
  - We want to keep the knowledge model as simple as possible to elicit all the user needs, but no simpler



General Model Architecture



Conclusion

- MBSE can aid in defining needs and functionality early in the development cycle
- By applying analysis and rigor to the development of a set of Users, or User classes, we can develop a concise yet complete set of user needs
- Just as one user can have many needs, many users can have a shared need
- The person developing the user needs should have a good understanding of the user, and interact with them where possible, to enable user interests to be appropriately defined

Take Home Message

User needs and other stakeholder requirements should be **identified** and described from the perspective of **each** class of **stakeholder**

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So, thanks to all at once and to each one

Questions?

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